A SKETCH OF THE FLORA OF SOUTHERN CALIFORNIA.

S. B. PARISH.

(*Concluded from p. 222.*)

THE CISMONTANE AREA.

THE genera which are confined to this area are more in number than the distinctive genera of both the other areas combined. Some of them have so wide a range as to deprive them of any but the most general phytogeographical value, and these are omitted from the following table. I have designated by an asterisk those genera which are represented by species that come to us from the south; the others are of northern affinity, and, with the exception of a few belonging to the central valley of California, are plants of the Pacific coast flora.

DISTINCTIVE GENERA OF THE CISMONTANE AREA.

Interior Subregion	Coastal Subarea	Common to Both Subareas	
Fimbristylis	*Acalypha	Adenostoma	Eremocarpus
Githopsis	Achyrachaena	Alchemilla	Godetia
*Imperata	Arbutus	Amorpha	Heterotheca
Juglans	Boykinia	Apiastrum	Heteromeles
Koelia	Calamintha	Athysanus	Loeflingia
Lagophylla	*Cneoridium	Baeria	Mecanopsis
Phragmites	*Cupressus	Cardamine	Oenanthe
*Schoenus	Eryngium	Caucalis	Palmerella
Umbellularia	Grindelia	Chlorogalum	Papaver
	*Harpagonella	*Conyza	Pickeringia
	Micromeria	Corethrogyne	Platystigma
	Myrica	Datisca	Platanus
	*Oxalis	Dendromecon	Scrophularia
	Sphacele	Dentaria	Tropidocarpum
		Dicentra	Valerianella

From a study of the distribution of the avifauna of California[24] Mr. Charles E. Kellar was led to propose a transitional area to embrace a strip of territory from the Coast Mountains, and including them, to the sea; and extending from Monterey

[24] KELLAR, CHAS. E., Geographical distribution of land birds in California. Zoe 1: 296, and map.

into Lower California. This area is characterized by the presence of forms from the Pacific coast, the Californian and the Sonoran areas, as these are laid down by Dr. Merriam.[25] The same conclusion is reached by a consideration of the floral distribution of the region. In its upper portion genera and species which are distinctively of the northern coast flora are both numerous and abundant; passing southward these become fewer and rarer. Many entirely fail to reach our part of this area, while others, like *Myrica Californica* and *Arbutus Menziesii*, are here local varieties. On the other hand, distinctively Sonoran plants, such as the yuccas and the Cactaceae, common in the south, drop out as one passes northward. At no point can a dividing line be drawn; and there is an important element of the flora, in considerable part connecting it with that of the Californian area, which is about equally abundant throughout the whole region.

The table last given, of genera exclusively Cismontane, shows but a weak Sonoran element, and from it one might infer that the flora of this area was overwhelmingly Coastal and Californian. But the table exhibits only half the truth, since the Sonoran element is represented mostly by genera which the Cismontane area shares with the Desert. Indeed, so prevalent is this element that it gives the flora an aspect decidedly Sonoran. The abundance of yuccas and the large development of the Cactaceae have been mentioned already. Some other desert plants that pass into the Cismontane are *Prosopis juliflora*, *Bebbia juncea*, *Philibertia linearis*, *Chilopsis saligna*, *Abronia villosa*, *Encelia farinosa*, *E. Californica*, *Viguiera deltoidea* var., etc. Omitting species that merely enter the respective borders of one area or the other through the different passes, there are over forty species of the Desert fairly frequent throughout the Cismontane, or a considerable part of it; on the other hand, hardly a single distinctively Cismontane species more than enters the confines of the Desert.

A small group of plants, which have entered directly from Lower California, inhabit a narrow strip along the coast. Some barely pass our borders; few penetrate very far within it, and

[25] MERRIAM, J. HART, N. Am. Fauna 3, map 5.

the last one disappears at Santa Barbara. They are enumerated below.

PENINSULAR SPECIES ALONG THE COAST.

Acalypha Californica	Cneoridium Californicum	Mamillaria dioica
Agave Shawii	Dithyrea Californica	Opuntia prolifera
Arctostaphylos diversifolia	Frankenia Palmeri	Opuntia serpentina
Baccharis sarothroides	Isomeris arborea	Simmonsia Californica
Beloperone Californica	Iva Haysiana	Viguiera laciniata
Cereus Emoryi		

The Cismontane area comprises two fairly distinct subareas. These probably owe the differences of their floras to the fact that one is more exposed than the other to the fogs and humid air of the ocean. The line separating them follows those elevations which intercept the direct action of these influences; namely, the seaward flanks of the Cuyamaca and Palomar Mountains, the Temecula Range, and the lower hills which continue it beyond the Santa Ana River.

The district between this line and the Pacific Ocean may be called the Coastal subarea; that between this line and the San Bernardino Range constitutes the Interior subarea. The latter subarea includes the San Fernando, San Bernardino, and San Jacinto Valleys. Where the wide Los Angeles Valley opens out to the sea the two subareas coalesce, and some of the most characteristic Coastal species are carried inland to the base of the San Gabriel Mountains.

The most evident characteristic of the Coastal subarea is the prevalence of oaks. Its rolling hills are covered commonly with open groves of *Quercus Engelmanni* and *Quercus agrifolia;* indeed, the first of these oaks and *Rhus laurina* may be considered the characteristic arboreal plants of this subarea. Its chaparral is much more largely composed of scrub-oak, mostly *Quercus dumosa*, than that of the Interior, where *Adenostoma fasciculatum* is the principal shrub. But the Interior subarea differs from the Coastal mostly in a negative way; the latter possessing fully one hundred species which do not extend into the former. Among these are eight species of Atriplex, five each of Chorizanthe and Phacelia, four each of Gilia and Antirrhinum, and three each of Astragalus, Calochortus, Cotyledon, and Salvia.

The species which are restricted to the Interior subarea are comparatively few and unimportant. Some which contrast with Coastal species may be named.

SPECIES RESTRICTED RESPECTIVELY TO THE INTERIOR OR THE COASTAL SUBAREAS.

Interior Subarea	Coastal Subarea
Adiantum Capillus-Veneris	Adiantum emarginatum
Andropogon macrourus	Andropogon saccharoides
Antirrhinum glandulosum	Antirrhinum Nevinianum
Aplopappus linearifolius	Aplopappus ericoides
Artemisia Parishii	Artemisia Palmeri
Boykinia rotundifolia	Boykinia occidentalis
Calochortus Plummerae	Calochortus Weedii
—— splendens	—— Dunnii
Carex Barbarae	Carex spissa
Chorizanthe Fernandina	Chorizanthe laciniata
—— Parryi	—— fimbriata
Euphorbia ocellata	Euphorbia misera
Gilia Californica	Gilia floribunda
Helianthus Parishii	Helianthus Oliveri
Hemizonia Wrightii	Hemizonia virgata
Lathyrus laetiflorus	Lathyrus splendens
Monardella Pringlei	Monardella hypoleuca
Opuntia Bernardina	Opuntia prolifera
Phacelia Davidsonii, var.	Phacelia Douglasii
Ribes glutinosum	Ribes speciosum
Zauschneria Californica	Z. Californica microphylla

There are also certain plants that are confined to the immediate shores of the ocean, either on the sands of the beach, or in the tidal marshes or meadows that occur in some places. These are exhibited in the subjoined table.

LITTORAL PLANTS.

Arenicolous Species	Halophilous Species
Abronia maritima	Astragalus pycnostachys
—— umbellata	Atriplex hastata
Amblyopappus pusillus	Batis maritima
Aphanisma blitoides	Jaumea carnosa
Atriplex leucophylla	Juncus acutus, var.
—— microcarpa	Lasthenia Coulteri
Calandrinia maritima	Monanthochloe littoralis
Convolvulus Soldanella	Salicornia ambigua
Franseria bipinnatifida	—— herbacea
Mesembryanthemum aequilaterale	—— mucronata
—— crystallinum	Scirpus Tatora
—— nodiflorum	Spartina glabra
Oenothera viridescens	Statice Limonum, var.

THE INSULAR FLORA.

The islands of Santa Catalina and San Clemente, situated some twenty miles off the seacoast, have floras of great interest. They are parts of that general coast-island flora which has received no little attention, not only by reason of certain anomalous elements in its composition, but as well from the problems of origin and affinity to which these give rise.

It has been contended that the coast islands are the emergent peaks of a submerged continent, still retaining the vestiges of its peculiar vegetation. Emergent peaks they certainly are, but a more reasonable theory regards them as belonging, not to another continent, but to a chain of mountains paralleling the present Coast Range, now, save for them, sunk beneath the waters of the ocean, whose waves roll over what was once a broad valley separating the two ranges. Under this theory the peculiar insular plants, such as Lyonothamnus and the species of Lavatera, are to be regarded as the remnants of a flora, antedating the period of subsidence, once common to the whole coast region. Preserved by its isolation on the islands, it has perished on the main-land, or is, perhaps, still feebly represented by a few species, such as *Pinus Torreyana* and *Euphorbia misera*, which retain a precarious foothold along the coast.[26]

[26] The following papers will be found of interest to those desirous of studying the insular floras and their relationship and probable origin:

BRANDEGEE, T. S.—Convolvulus occidentalis. Zoe 1: 85. Plants of Santa Catalina Island. Zoe 1: 107. Flora of the Californian islands. Zoe 1: 129. Lavatera—is it an introduced plant? Zoe 1: 188. Flora of the Santa Barbara Islands. Proc. Cal. Acad. II. 1: 201.

DAVIDSON, GEORGE.—The submerged valleys of the coast of California, U. S. A., and of Lower California, Mexico. Proc. Cal. Acad. III. Geo. 1: no. 1.

GREENE, E. L.—Notes on the botany of Santa Cruz Island. Bull. Cal. Acad. 2: 377. A botanical excursion to the island of San Miguel. Pittonia 1: 74.

LE CONTE, JOSEPH.—The flora of the coast islands of California in relation to recent changes in physical geography. Bull. Cal. Acad. 2: 377.

LYON, W. S.—The flora of our southwestern archipelago. BOT. GAZ. 11: 197, 230.

PARISH, S. B.—The Pacific Lavateras. Zoe 1: 300. Southern extension of the range of *Polypodium Scouleri*. Fern Bull. 9: 40.

TRASK, BLANCHE.—Field notes from Santa Catalina Island. Erythea 7: 128.

WATSON, S.—Flora of Guadalupe Island, Lower California. Proc. Am. Acad. 11: 105.

YATES, L. G.—Stray notes on the geology of the Channel Islands. Rept. Cal. State Mineral. 9: 171. Insular floras. *L. c.* 179.

The number of the endemic species of plants occurring on the coast islands was claimed, at one time, to be much larger than is admitted at present. Among them are the remarkable monotypic Lyonothamnus, and Lavatera, with four too closely allied species, no two of them found on the same island, a genus which is unrepresented elsewhere in the western world. All the other endemic insular species belong to genera which have representatives on the adjacent mainland. Probably less than thirty of these species are valid, and of these several are no more than robust developments of plants of the neighboring coast. Twelve of them are found on the islands off the Mexican coast, as well as on the Californian islands, so that hardly more than fifteen remain which are peculiar to the latter group.[27] In the subjoined list species endemic to Santa Catalina and San Clemente are in italic; species too closely connected with continental ones, perhaps mere varieties of them, are designated by an asterisk.

PLANTS OF SANTA CATALINA AND SAN CLEMENTE ISLANDS.

Astragalus Nevinii	Galium Catalinense	Lyonothamnus floribundus
*Ceanothus arboreus	Gilia Nevinii	Malacothrix foliosa
**Cercocarpus Traskae*	*Hemizonia Clementina*	—— insularis
*Crososoma Californica	Lavatera assurgentiflora	*Plantago dura*
*Eriogonum giganteum	*Phacelia Lyoni*	Quercus tomentella
Eriophyllum Nevinii		

These distinctively insular species constitute but an insignificant proportion, although a most interesting element, in the plant population of the islands, which, with these exceptions, is made up of species from the neighboring mainland. The islands are therefore to be considered as a subarea of the Cismontane area, and but slightly differentiated from the Coastal subarea.

PHYTOGEOGRAPHICAL DIVISIONS.

In accordance with the views set forth above, the life-areas of southern California are exhibited in the subjoined table. They are provisional merely, for not only does much remain to be learned of the distribution of our flora, but they are based on an examination of the flora alone, whereas the fauna and avifauna

[27] BRANDEGEE, T. S. Zoe 1 : 129.

must also be taken into consideration. It is believed, however, that the divisions here laid down will not be greatly modified when all the facts bearing on the problem come to be known.

LIFE AREAS OF SOUTHERN CALIFORNIA.

Provinces	Regions		Areas	Subareas
Boreal	Arctic		Alpine	
	Boreal	Nevadan	Hudsonian	
			Canadian	
			Transition	Upper
				Lower
Sonoran	Lower Sonoran		Desert	Mojave
				Colorado
	Upper Sonoran		Cismontane	Interior
				Coastal
				Insular

The various life-zones in an ideal section across southern California, from the lowest point in the deserts, across the highest mountain peak, to the coast islands, are represented below:

IDEAL SECTIONAL DISPOSITION OF THE LIFE-ZONES.

Alpine	
Hudsonian	
Canadian	
Upper Transition	
Lower Transition	
Juniperus Zone	Pseudotsuga Zone
Piñon Zone	Interior Subarea
Yucca Zone	Coastal Subarea
Larrea Zone	Littoral Zone
Atriplex Zone (?)	Insular Subarea

INTERRELATIONS OF THE DIFFERENT LIFE-AREAS.

It is not to be understood that these various phytogeographical subdivisions are strictly limited and sharply defined, as they are represented on biological charts. Here, as always, nature does not pass with abruptness from one formation to another; rather one shades gradually into another. Thus we find few, if any, species where boundaries are strictly conterminous. And in passing across the country a successive and continuous disap-

pearance of species is observed, and the appearance of new ones in their places.

Under the varying influences of soil, moisture, exposure, wind currents,[28] and other subtler, and often unrecognizable, causes, adjoining zones interpenetrate and overlap each other in a most irregular manner. Nevertheless they have a real existence and evident boundaries, manifested by the general character of the vegetation. The most unobservant quickly notices the change from one kind of plant growth to a very different kind, as he passes from the Desert to the Nevadan or the Cismontane areas. The trained eye of the botanist notes in each the limits of several subareas, yet detects in each plants seen also in the others.

The interrelation of the floras of the several areas is manifested by the numerous genera which have representative species in each. Most of them show, by the larger number of species growing in it, the area where the conditions are best suited to their development, and, when the preference is well marked, that area may be considered the one to which they specially belong. Some of the larger of these genera are tabulated below:

INTERRELATIONS OF GENERA.

Genera	Species and Varieties			Genera	Species and Varieties		
	Nevadan	Cismontane	Desert		Nevadan	Cismontane	Desert
Allium	3	3	2	Gilia	11	29	19
Arabis	5	1	2	Hosackia	5	19	4
Astragalus	7	6	17	Juncus	6	5	1
Atriplex	0	10	7	Krynitzkia	1	6	11
Calochortus	1	9	3	Lupinus	9	16	3
Carex	23	10	1	Mimulus	10	11	2
Chaenactis	2	3	6	Phacelia	4	16	12
Chorizanthe	2	11	6	Plagiobothrys	1	6	1
Eriogonum	10	9	20	Pentstemon	5	8	6
Trifolium	2	15	0	Ranunculus	5	3	0

While most plants have a definite and often very restricted range, others are able to adapt themselves to such various environments that their limits are circumscribed by no narrower

[28] The influence of wind currents from the deserts is very potent in disturbing the life-zones in the narrow Nevadan belt; and in a similar manner the moist winds from the ocean modify the boundaries of the Interior and Coastal subareas.

boundaries than those of a biological province. Plants such as these are without phytogeographical value in the study of more limited areas. For an opposite reason plants which are very localized are likewise without value. Only those whose limits are neither too widely extended nor too restricted are serviceable to the phytogeographer in determining the biological subdivisions of a region. For this purpose trees and shrubs are more useful than humbler plants. Not only are they more readily observed, but their greater duration requires a closer adaptation to climatic conditions, while their stature and their depth of root render them less immediately dependent on conditions of pure locality, such as surface moisture or shelter.

PHYSIOGNOMIC CHARACTERISTICS OF THE FLORA.

The most striking feature of the southern Californian flora, taken as a whole, is the prevalence of shrubs. The Nevadan is, indeed, largely a forested region; but its open growth is interspersed with vast tracts of chaparral, and altogether fails to produce an effect comparable to the vaster and denser forests of moister climes. Except in the mountains, trees are seldom numerous, and when present form park-like groves rather than true forests. Each region has, too, its meadows, never of large extent, and except in the mountains mostly confined to soils somewhat alkaline.

But throughout the whole territory, shrubs form the common plant-covering of plain and hillside. In the higher mountains impenetrable thickets of *Castanea sempervirens* and *Ceanothus cordulatus* extend for miles. Lower on the Cismontane slope other species of Ceanothus, intermixed with Arctostaphylos, Rhamnus, Ribes, and many other shrubs, cover expanses as wide. To these succeed dense chaparrals of Adenostoma and scrub-oak.

But it is in the deserts that this characteristic is especially developed. Large areas are thickset with opuntias, or with a great variety of other shrubs, daleas, lyciums, ephedras, tetradymias, and many others, whose rigid and thorny growth renders passage painful or impossible. Indeed, in this region, and to a considerable extent in the Cismontane as well, for half the year

the ligneous plants appear to constitute almost the sole vegetation, since the annuals and the aerial parts of most herbaceous plants disappear in the dry season. And even in the rainy months, the superiority of the herbs over the shrubs, in number of species and of individuals, is concealed by their smaller and often insignificant size.

The subjoined table exhibits the vegetative character of the indigenous plants of the different areas. In compiling it I have omitted varieties, doubtful and obscure species, or the few which cannot be satisfactorily credited to any one area. This, it is believed, more fairly represents the prevalent characters of the plant populations, than would the inclusion of every rare and questionable plant.

VEGETATIVE CHARACTERS OF THE FLORA.

Areas	Annuals and Biennials	Herbaceous Perennials	Shrubs	Trees	Total
Desert	167	86	142	9	*404*
Nevadan	79	296	43	19	*437*
Cismontane	359	306	123	25	*813*
TOTAL	*605*	*688*	*308*	*53*	*1,654*

I have classed as trees all those which in southern California commonly attain to fifteen feet (4.5^{m}) in height, and have a tree-like trunk. Of trees 50–100^{ft} (15–30^{m}) high the Cismontane has six, the Nevadan four, and the Desert one; the Nevadan has six which exceed this height, but the other areas none.

RELATIVE PROPORTIONS OF THE DIFFERENT CLASSES OF PLANTS.

Areas	Annuals and Biennials	Herbaceous Perennials	Shrubs	Trees	Total
Desert	0.41	0.21	0.25	0.03	0.24
Nevadan	0.18	0.68	0.10	0.04	0.27
Cismontane	0.44	0.37	0.15	0.03	0.49
Southern California...	0.365	0.415	0.186	0.032	

The figures in the first four columns of the above table show the percentages which the number of species in each class of

plants bears to the whole number of species in each area; those in the footing show the proportion of each class in reference to the whole flora of southern California. The right-hand column shows the proportion which the total flora of each area bears to the whole flora.

It appears by these tables that there is a notable difference in the development of the various classes of plants in the several areas. Thus the Desert has the largest proportion of shrubs and the smallest of perennials herbs—a condition which is exactly reversed in the Nevadan area. The Desert and the Cismontane areas have nearly an equal percentage of annual species, and each has more than twice as many as the Nevadan. It also appears that the Cismontane has nearly as many species as both the other areas combined. The percentage of arboreal species is unexpectedly found to be nearly the same in each region, but could the comparison be made between the number of individual trees in each area, the Nevadan would far exceed the others.

The principal cause of these differences is doubtless to be found in the climatic character of the several areas. The short season of winter rainfall in the two Sonoran areas permits the development of annual plants, but is unfavorable to perennial herbs. The cooler climate, and the numerous living streams and springs in the Nevadan area are more favorable to perennials than are the conditions in the other areas. Why the proportion of shrubby species should be so much smaller in the Nevadan than in either of the other areas is less evident, but it is probably due to the occupation of the land by trees, whose shade discourages the multiplication of shrubs. But it is also a fact that the chaparral of this area, while extensive, is composed of fewer species than is the same formation in the other areas.

ADAPTATION OF PLANTS TO CLIMATIC CONDITIONS.

The chief condition of their environment, as I have already stated, to which the plants of southern California have to adapt themselves, those which are paludose or aquatic excepted, is the aridity of the climate, resulting from prevalent high temperature, and a scanty and irregular precipitation. This necessity to some

extent affects even those plants which inhabit the higher mountains, but in a less degree than those which grow at lower altitudes. The mountain plants have a far greater need of protecting themselves against the low temperature of winter. Hence many of them are perennial herbs, which are able to preserve through the winter the vitality of their roots, safely buried in the soil, although the aerial portions perish from the cold. And as the air is here cooler and moister, more plants are found with broad and unprotected leaves than in the other areas.

It is in these other areas that there is the greatest development of the protective adaptations which enable a plant most fully to utilize a scanty supply of water. The methods by which this is effected are three: by habits of growth; by provisions for storing supplies of water and food in times of plenty as reserves for times of need; and by contrivances for diminishing the loss of water through evaporation.

The first of these methods is well exemplified by most of the xerophytic annuals. They spring up at once after light rains, and put forth no more than a leaf or two before proceeding to the production of a flower and a fruit. If moisture now fails, reproduction is assured; should it continue to be supplied, branches are sent out and flowers and seed multiplied. Thus a plant when receiving only a little moisture may fulfil the cycle of existence and provide for the continuance of its species, without attaining an inch of stature; but under more favorable conditions it may attain dimensions of two or three feet.

The xerophytic perennial herbs make their growth in the wet season, and, in most cases, the aerial stems perish at the beginning of summer. Thus they reverse the seasons, remaining dormant in summer to survive the heat, just as in colder climates they remain dormant in winter in order to survive the cold.

The same reversal of the seasons is the habit of many of the deciduous shrubs. They put forth their new foliage in early winter, make their growth during the wet season, and, ripening their fruits in spring, drop their foliage when the droughts of summer come on, remaining leafless and dormant until its con-

clusion. This may be said to be the rule with desert shrubs, and it also prevails to a considerable degree in the Cismontane area.

The storage of supplies at times when they are attainable, so that vitality may be preserved through a season when they cannot be secured, is provided for by a thickening of either the stems or the leaves.

The engorgement of the underground stem or its buds, whereby bulbs and tubers are produced, is comparatively rare among the plants of our region. Among the xerophilous plants of the Desert there are but two bulbs, *Hesperocallis occidentalis* and *Calochortus Kennedyi;* and there are two species of Psoralea and three or four cucurbits which have tuberous roots. A few plants, like the lomatiums, have thickened roots. In the Cismontane area the list of plants of this kind is longer, but not greatly.

The Cactaceae are our only examples of the modification of the above ground stem for storage purposes. During the wet season these stems become plump and full of sap, but at the conclusion of the dry season, they are shrunken and corrugated. This is especially noticeable in the opuntias, but it may be observed also in the appearance of the ribs or the mamillae of the other genera at the different seasons.

Storage in the leaves is exemplified by the agaves, the cotyledons, and the sedums. The leaves of these plants also become more or less shrunken by the end of the dry season.

But much commoner than these modifications are the protective devices by which transpiration is limited. Few are the plants of the deserts which have not acquired one or more adaptations whereby this result is effected. Some, like canotia, the ephedras, the cereuses, and the echinocactuses, are entirely leafless; others, like the opuntias, *Dalea spinosa*, and *Hoffmanseggia microphylla*, have the leaves few, small, and early deciduous. In plants such as these, the modified epidermis is chlorophyllous and performs the office of leaves. In place of the broad thin leaves displayed by the plants of moist climates, these denizens of the deserts have small and thick leaves, often with revolute edges and pinnate divisions. Very commonly the foliage or the whole plant is protected by a coat of hairs, wool, or scales, a var-

nish, or a powder, from the direct contact of the parching air of their arid habitat.

The same modifications are present also in the plants growing in the other areas, but they are not so marked and so prevalent as in the desert vegetation. The ferns may be taken as an example. Only one desert fern (*Notholaena tenera*) is unprotected by a coating of some kind, and although this has small and rigid leaves, its excessive rarity may be taken as an indication of its ill adaptation to its environment. None of the mountain ferns have protective coatings upon their fronds. Eleven of the twenty species belonging to the Cismontane area are destitute of such protective devices, and nine are furnished with them; the former being the species which grow in cool damp situations, and the latter those affecting habitats where the supply of moisture is less abundant or permanent.

STATISTICS OF CLASSIFICATION.

The following table presents a summary of the distribution of the flora into the several taxonomial categories. The fourth column under the head SPECIES shows the percentage of the species in each class to the total number of species. Only naturalized or adventive plants are included as introduced, no notice being taken of escapes or waifs. These exotics constitute but 7 per cent. of the species of the flora, a proportion smaller than is commonly found.

SYNOPTIC TABLE OF CLASSIFICATION.

Taxonomial Categories.	Families		Genera			Species				Varieties
	Native	Introduced	Native	Introduced	Total	Native	Introduced	Total	Per cent.	
Gamopetalae	32	1	216	19	*235*	714	51	*765*	38	55
Choripetalae	63	1	259	27	*286*	813	50	*863*	43	48
Dicotyledones	95	2	475	46	*521*	1,527	101	*1,628*	82	103
Monocotyledones	17	..	85	14	*99*	253	38	*291*	14	22
Angiospermae	112	2	560	60	*620*	1,780	139	*1,919*	97	125
Gymnospermae	2	..	7	..	*7*	21	...	*21*	1	1
Spermatophyta	114	2	567	60	*627*	1,801	139	*1,940*	98	126
Pteridophyta	7	..	20	..	*20*	41	...	*41*	2	2
Total	*121*	*2*	*587*	*60*	*647*	*1,842*	*139*	*1,981*		*128*

Of the families forty-eight are represented by a single genus each, and thirty-eight of these each by a single species. The families which have the most numerous species are shown below, arranged in the sequence of the species:

GENERA AND SPECIES OF THE LARGER FAMILIES.

Families	Genera		Species		Families	Genera		Species	
	Native	Introduced	Native	Introduced		Native	Introduced	Native	Introduced
Compositae.....	99	13	294	25	Labiatae	18	3	44	4
Leguminosae	24	2	149	5	Rosaceae	21	..	42	..
Gramineae.....	37	13	95	30	Chenopodiaceae .	10	3	36	3
Polygonaceae	10	..	85	4	Filices	13	..	30	..
Scrophulariaceae..	14	1	84	1	Ranunculaceae ..	8	..	28	..
Cyperaceae.....	8	..	60	..	Cactaceae.....	4	..	28	..
Cruciferae.....	18	5	51	11	Euphorbiaceae ..	7	1	24	2
Polemoniaceae...	3	..	55	..	Solanaceae	6	..	22	5
Umbelliferae.....	21	6	45	8	Saxifragaceae ...	10	..	25	..
Onograceae	7	..	53	..	Rhamnaceae	4	..	21	..
Hydrophyllaceae..	9	..	52	..	TOTAL.....	351	47	1,323	98

From the above table, it appears that these twenty-one families, being but 17 per cent. of the total number of families, include 71 per cent. of all the species which belong in the flora, and that the first ten families include 52 per cent. of the species. Over 16 per cent. of the entire number of species are found in the Compositae, 8 per cent. in the Leguminosae, 6 per cent. in the Gramineae, and 4 per cent. each in Polygonaceae and Scrophulariaceae.

Some of these families, as the Compositae, the Gramineae, and the Cruciferae, owe their prominence to a large number of genera of a few species each; but in others this is due to two or three genera, or even a single genus which has many species. Thus the large development of the genus Phacelia gives importance to Hydrophyllaceae, of Gilia to Polemoniaceae, and of Carex to Cyperaceae; while the rank of the Leguminosae results from the numerous species of Hosackia, Trifolium, Lupinus, and Astragalus, and that of the Polygonaceae from the many species of Eriogonum and Chorizanthe. In the following table the genera which have fifteen or more species are arranged in the order of their number:

GENERA WHICH CONTAIN THE MOST SPECIES.

Genera	Species	Genera	Species
Gilia	52	Trifolium	20
Eriogonum	41	Atriplex	19
Astragalus	35	Chorizanthe	19
Phacelia	30	Mimulus	19
Carex	30	Juncus	18
Lupinus	27	Pentstemon	18
Hosackia	22	Opuntia	16
Krynitzkia	20	Galium	15

The above sixteen genera contain 401 species, or 20 per cent. of all the species of the region. Except a single species of Trifolium, they are all indigenous. It is worthy of notice that these most largely developed genera, with a few exceptions, are distinctively western American.

AFFINITIES OF THE FLORA.

On a previous page I have attempted to indicate the more immediate sources from which our flora has been derived, but it may not be without interest to glance briefly at its relation to the wider problems of plant distribution. For this purpose the families may be divided into three groups: first, those of such equal development in the several zones as be accounted cosmopolitan; next, those having their greatest development in the temperate zone; and, lastly, those whose centers of development are in or near the tropics.

Such an arrangement is shown in the table on the opposite page; Phytolaccaceae and Dipsaceae being omitted, since they are represented only by introduced species. The columns of percentage indicate the proportion of the number of families in each regional division to the whole number of families in each taxonomial group.

It appears from this table that the families, leaving out of consideration the cosmopolitan ones, which, being of general distribution, have no present signification, are about equally divided between the tropical and the extra-tropical groups; a result to be expected from the geographical and climatic position of the region.

REGIONAL AFFINITIES OF THE FAMILIES.

Taxonomial Categories	Cosmopolitan		Extratropical		Tropical and Subtropical	
	Families	Per cent.	Families	Per cent.	Families	Per cent.
Gamopetalae.....	12	37	8	25	12	27
Choripetalae.....	24	38	21	33	18	29
Dicotyledones.....	36	38	29	30	30	31
Monocotyledones...	12	70	2	11	3	17
Angiospermae.....	48	43	31	28	33	29
Gymnospermae.....	..	..	1	50	1	50
Spermatophyta.....	48	43	32	28	34	29
Pteridophyta.....	4	57	1	14	2	28
Total.....	*52*	*43*	*33*	*27*	*36*	*30*

In the next table are exhibited the relations of the native genera and species to the flora of North America. The number of each which extend beyond the North American continent is shown; and those which are confined to it are separated into four geographical subdivisions; namely, those whose range is restricted respectively to southern California, to California, to the region west of the Rocky Mountains, and those which extend further eastward. While the line has been drawn very strictly between plants which are or are not exclusively North American, and as accurately as possible for those confined to western North America, a somewhat laxer rule has been observed for the two smaller subdivisions. These are merely political, and have little phytogeographical significance, and the limits of many of their plants as yet are not known accurately. For these reasons there are included in the number accredited to California, and to southern California, some plants which, while properly belonging to them, extend a little beyond their boundaries.

This table brings out very clearly the distinctively west American character of the flora. Two-thirds of the genera, it is true, extend their range beyond North America; but of the remaining one-third, only 14 per cent. are found east of the Rocky Mountains, while 86 per cent. of this third are confined to the territory west of them, and of these about half

REGIONAL DISTRIBUTION OF GENERA AND SPECIES.

Taxonomic Categories	Genera						Species					
	Endemic					Extra North American	Endemic					Extra North American
	North American	Western N. American	Californian	Southern Californian	Total		North American	Western N. American	Californian	Southern Californian	Total	
Gamopetalae	13	54	16	6	*89*	127	22	250	164	221	*657*	57
Choripetalae	9	42	11	7	*69*	190	55	259	207	187	*708*	105
Dicotyledones	22	96	27	13	*158*	317	77	509	371	408	*1365*	162
Monocotyledones	3	4	3	3	*13*	72	43	88	40	32	*203*	50
Angiospermae	25	100	30	16	*171*	389	120	597	411	440	*1568*	212
Gymnospermae	..	1	..	..	*1*	6	...	13	5	3	*21*	...
Spermatophyta	25	101	30	16	*172*	395	120	610	416	443	*1589*	212
Pteridophyta	..	...	..	..	...	20	4	9	2	6	*21*	20
Total	*25*	*101*	*30*	*16*	*172*	*415*	*124*	*619*	*418*	*449*	*1610*	*232*
Per cent. of native flora	4	17	5	3	30	70	6	33	23	24	87	12

are restricted to California. It will also be noticed that the geographical specialization rapidly increases in passing from the lower to the higher taxonomial groups. Thus all the genera of Pteridophyta extend beyond the North American continent; of the seven genera of Gymnospermae only one is exclusively North American; of the Monocotyledones 15 per cent. are North American, but of the Choripetalae 26 per cent., and 41 per cent. of the Gamopetalae.

Naturally this local differentiation is much more pronounced in the species than in the genera. Less than one-eighth of the indigenous species extend beyond North America. Among the North American species less than 8 per cent. pass beyond the Rocky Mountains; of the species occurring west of that range nearly 60 per cent. are exclusively Californian; of the Californian species over one-half are confined to the southern counties. In the Pteridophyta the species are about equally divided between North American and those of wider distribution; the development of the Gymnospermae is entirely North American; the Monocotyledones are 80 per cent. North American, the Choripetalae 88 per cent., and the Gamopetalae 92 per cent.

COMPARATIVE RICHNESS OF THE FLORA.

A few figures are given below showing the comparative number of species in the southern California and some other floras. The last column indicates the proportion which the species of each flora bears to that of America north of Mexico.

COMPARATIVE TABLE OF FLORAS.

Region	Authority	Date	Area Sq. Miles	Species	Sq. Miles to each Species	Per cent.
N. Am. excl. Mexico	Heller, Cat. N.A. Pl.	1898	.....	14,534	....	..
N. & NW. U. S. Canada, etc.	Britt. & Br., Ill. Fl.	1898	.....	4,162	....	28
Ohio	Kellerman, 4th Cat.	1899	39,964	2,025	19.7	14
Michigan	Beal & Wheeler, Mich. Fl.	1892	56,451	1,746	32.3	12
Montana	Rydberg, Fl. Mont.	1900	145,776	1,676	89.8	11
Alabama	Mohr, Ala. Pl. Life	1901	50,272	2,525	20.0	17
California	Brew. & Wats., Bot. Cal.	1880	156,511	2,956	52.9	20
Southern California	Parish, MS. Cat.	1900	40,889	1,981	20.6	13
Great Britain	London, Cat. 7th Ed.	1877	89,077	1,665	53.5	..

The superiority in number of species of the flora of Ohio, a state having nearly the same area as southern California, is unexpected, in view of the far greater diversity of physical conditions in the latter region. To some extent this is due to an estimate of specific values somewhat more conservative in the enumeration on which the southern California figures are based than obtained in that for Ohio. But mostly it is owing to the fact that the Ohio flora has been long studied, and by numerous able botanists, while our own has had few students, who have worked under disadvantages, and for a relatively short time. Our flora, consequently, is known imperfectly, while that of Ohio has been worked up thoroughly. Additions to it must come mostly from occasional new introductions, or from the segregation of known species. But with us every year's observations of the few resident botanists add a considerable number of species, either new or not previously reported from our region.[29] Other additions are frequently made by those who restudy the accumulated material in the great herbaria. Much territory remains almost wholly unexplored, some of which is certain to

[29] Since my catalogue was completed in 1900 enough additional plants have been reported to make the total number considerably over two thousand.

yield good returns to future explorers. When fully known, the southern California flora will probably contain not less than 2,500 species.

THE CRYPTOGAMIC FLORA.

In this sketch only the Spermatophyta and Pteridophyta have been considered; but below the ferns and their allies lie a series of plants perhaps more numerous than those above them. The relations of these plants, however, to the problems of the life-areas and geographical derivations of a flora is less definite, or at least less understood, than that of the higher groups. Consequently a consideration of them may be omitted in the investigation of these questions, with confidence that a fuller knowledge is not likely to require a reconsideration of the results arrived at.

The information which has been accumulated concerning the representation of these lower plants in southern California is very incomplete. It is almost wholly the result of the labors of two or three students, extended over a short period of time.

The pioneer resident investigator of these, as of the higher plants of the region, was Mr. Daniel Cleveland. In the lower groups he confined his attention to the marine algae of San Diego, and in 1885 published a list of 147 species. Harkness and Moore in their *Catalogue of Pacific coast fungi* (1880) knew of but seven species from the southern counties. More recently Dr. H. E. Hasse has devoted much study to the lichens, the results of which he has made known in several contributions to botanical journals, and by a *Catalogue of the lichens of southern California*, published in 1898. In this are enumerated 304 species, the largest genera being Lecidea, with 65 species, and Lecanora, with 73.

Beyond this almost all that is known of the lower plants of southern California is due to Professor A. J. McClatchie, who in his *Seedless plants of southern California* (1897) laid a broad foundation for future building. A thousand species are catalogued; the lichens are contributed by Dr. Hasse, but the other orders are treated by Professor McClatchie, and are based mostly on his own collections. The Protophyta number 84

species, the Phycophyta 87, the Carpophyta 748, and the Bryophyta 86.

The Musci and Hepaticae appear to be poorly represented in our flora, as might be expected from the arid environment. Of the former Professor McClatchie was able to enumerate but 63, and of the latter but 23, and few additions have since been made to these numbers. This compares poorly with the 312 Musci and the 90 Hepaticae known in the much smaller area of New Jersey.[30]

The lichen flora is more abundant, but is confined to species adapted to arid conditions. Fungi are less abundant than in regions enjoying a moister climate, and this is particularly true of the fleshy fungi. The algal flora, on the contrary, being for the most part unaffected by atmospheric aridity, and enjoying varied environments, is certainly very rich. Of its lower forms the diatoms are abundant and varied, but the desmids, to speak from my own experience, are discouragingly few.

If one descends still lower to those dubious organisms, the Myxomycetes, they also seem to have a very limited representation. For a number of years I have made the collection of the slime-molds a special object, but with very meager results. Only 18 species, representing 12 genera, have been obtained in a condition which permitted determination, a number less than might have been secured in an hour in more favorable climates. I have never found them in abundance, and seldom at all except after long-continued damp and rainy weather.

SAN BERNARDINO, CAL.

[30] BRITTON, N. L., Catalogue of Plants found in New Jersey. 1889.